Dynamic Design: Launch and Propulsion

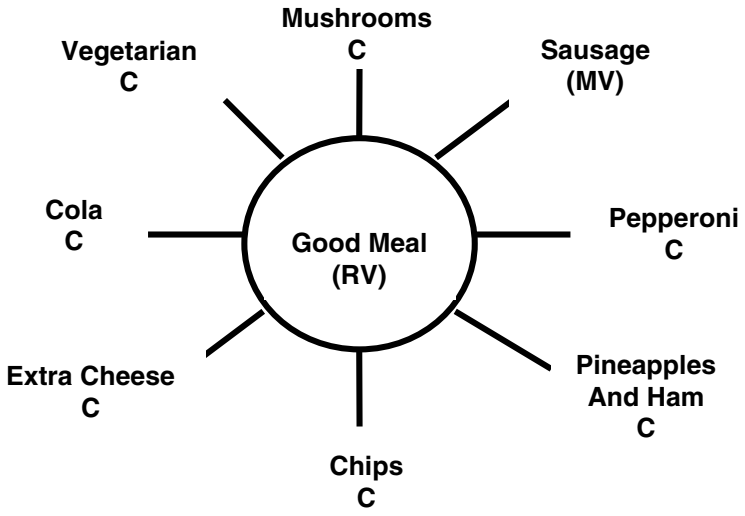
Variables & Operational Definitions

STUDENT TEXT

All of your friends arrived at your house for a Super Bowl party. After the first quarter your friends tell you that they are hungry. Everyone thinks pizza will satisfy his or her appetite. Before you call the local pizza shop, you ask everyone what their favorite toppings are. Three of your friends like sausage; one person wants vegetarian; five others want pineapple and ham; two people want pepperoni; and three people want plain with extra cheese. Heather says she wants potato chips and Gary says he wants some cola. Based on this information you call in your order.

The end result for all of the people at your party is the same. They want to satisfy their hunger by eating the pizza and to enjoy the experience by getting the topping they wanted as well as the chips and drink. We will call the result in this case a good meal.

Variables are the factors that are involved with an experiment, or in this case, a party. The **manipulated variable** in an experiment is the variable that is deliberately changed during an experiment to cause an effect. An experiment often has more than one variable that can be manipulated. The remaining variables should be kept constant. The manipulated variable in this example is one of the various toppings or side dishes. The **responding variable** is the factor that is affected in the experiment. The responding variable in this case is the friend's perception of a good meal. We can illustrate this with the use of a variable wheel.



The variable wheel has the responding variable in the center of the circle and the manipulating variables on the spokes. Let's say you wanted to play a trick on your friends and order mushrooms on all the pizzas to find out if they still considered it a good meal. We put this in the form of a question, "How does adding mushrooms to the pizzas affect my friends' perception of a good meal during a Super Bowl party?" In this case you would order the pizzas with the toppings of their choice AND mushrooms. As you might imagine, some people might like this; some would be ambivalent; and some would be upset and even pick them off.

How could you measure your friends' perception of a good meal? One way might be to observe their expressions as they see the pizza and eat the meal. Another way would be to listen for any verbal feedback. Yet another would be to observe the actions of your friends. A more formal way would be to give them a short survey about their reaction to the mushrooms on the pizza. All of these ways of measuring your friends' perceptions of a good meal are examples of **operational definitions.** Operational definitions are how we intend to measure the variables.

Having too many variables makes measuring the results more difficult or even impossible. In the case of the pizza experiment, let's say your operational definition of a good meal is to observe the expression on your friends' faces. Instead of ordering the pizzas with the toppings of their choice, you ordered supreme pizzas. Because there is more than one variable being tested at the same time, it is very difficult to determine which of the variables (toppings) affected whether a person considers it a good meal. In this case, it is important to keep all variables except the manipulated variable constant during the experiment. This way, it is easy for the experimenter to determine if that variable is the one that causes an effect for better or worse.

Some variables are hard to keep constant. For instance, let's say that some of the people at your party are rooting for the winning team, and some are rooting for the losing team. The people rooting for the winning team may perceive their meal to be better than the people who are rooting for the losing team. Other variables may contribute to your friends' perceptions of a good, average, or bad meal, such as the thickness of the crust of the pizza, the temperature of the pizza, or the flavor of the pizza sauce, even though you were not trying to measure this. Other environmental factors may contribute to the perceptions of your friends, such as if it is too hot or too cold in the room, or too loud or too quiet, or even their attitude about attending your party.

When planning an experiment, it is difficult to know all of the variables that may contribute to the result of your study. Using the variable wheel or listing the factors that might affect your experiment before you begin will help you be aware of these variables and deal with them during your experiment.

Throughout the activities in this module, the responding variable for the rocket activities is the height that the rockets will fly. The manipulated variables are what you will be working on to affect this. As you build your rockets you will notice that some variables have a greater effect than others. Your job during the interaction phase of this module will be to operationally define the manipulating variables that will be used in launching a water bottle rocket and the responding variable of height.